Space Weather Technical Forecast

Issued on Friday, 25 August 2023 at 01:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight chance of G1 Minor Storms early day 1 (26 Aug). Chance of isolated M-flares throughout (R1-R2 Blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low with peak flare C4.1 at 24/2214 UTC from AR3405 in the northwest. There are five sunspot region on the disc. The most complex is AR3415 in the southeast which has persisted as a modestly sized penumbral area containing two opposite polarity umbra, but showing very little activity. AR3413 in the northeast exhibited decay within its trailer, however this is positioned to the north of the main dominant leader spot. This maintains some potential instability across the region due to its east-west polarity separation line. The other spots were also smaller mature, unipolar spot, including AR3405.

No Earth-directed CMEs have been observed. The C4.1 flare of AR3415 had an associated coronal dimming event, but no CME has been detected. A CME was observed from the previous LP C3.0 flare at 24/2033 UTC, however this was from over the northwest limb.

Solar Wind / Geomagnetic Activity: A transition into the fast wind of CH39/+ was observed. Solar wind speeds were slightly elevated at 400-440km/s until around 24/1500 UTC, then rose gradually to peak just over 500km/s by 24/1820 UTC, and then persisted slightly elevated 460-500km/s. Density rose from below average to be average from 24/1638 UTC. The interplanetary magnetic field (IMF) Bt, was mainly weak but briefly rose to Moderate, peaking 9nT around 24/1600 UTC, before declining to persist around 4-6nT from 24/1630 UTC. The north-south component was mainly positive until 24/1200 UTC, then variable with minimum/peak values of -8nT and +8nT until 24/1740 UTC. A rotation from weakly negative (southward) to near neutral values followed. The Phi angle was initially negative (towards the Sun) but rotated to be positive (away from the Sun) from 24/1700 UTC. Geomagnetic activity remained was Quiet at first (Kp 0-2), but became Unsettled (Kp3) from 24/1500 UTC.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at Background. GOES16 high energy (greater than 2MeV) electron flux was Background to Moderate, peaking 600 pfu at 24/1535 UTC. The associated 24-hour fluence was well below the Active level, with a flat trend and an observed value of 1.21e7 integrated pfu at 24/2100 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar Activity is expected to be generally Low, but with a chance of isolated M-class flares. These most likely from AR3415 or AR3413.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Ongoing fast wind influence from CH39/- at first with winds around 500km/s. This easing day 1 and 2 (25-26 Aug) with a further enhancement then possible from central disc CH38/+ or northern disc CH37/+, either late day 2 or day 3 (26-27 Aug). Unsettled to Active geomagnetic activity is forecast at first, with a slight chance of G1 Minor Storm intervals. This easing early day 1 (25 Aug) to become mainly Quiet with isolated Unsettled intervals. The arrival of any CIR and associated fast wind of CH38/+ late day 2 or day 3 (26-27 Aug) is then forecast to increase activity to

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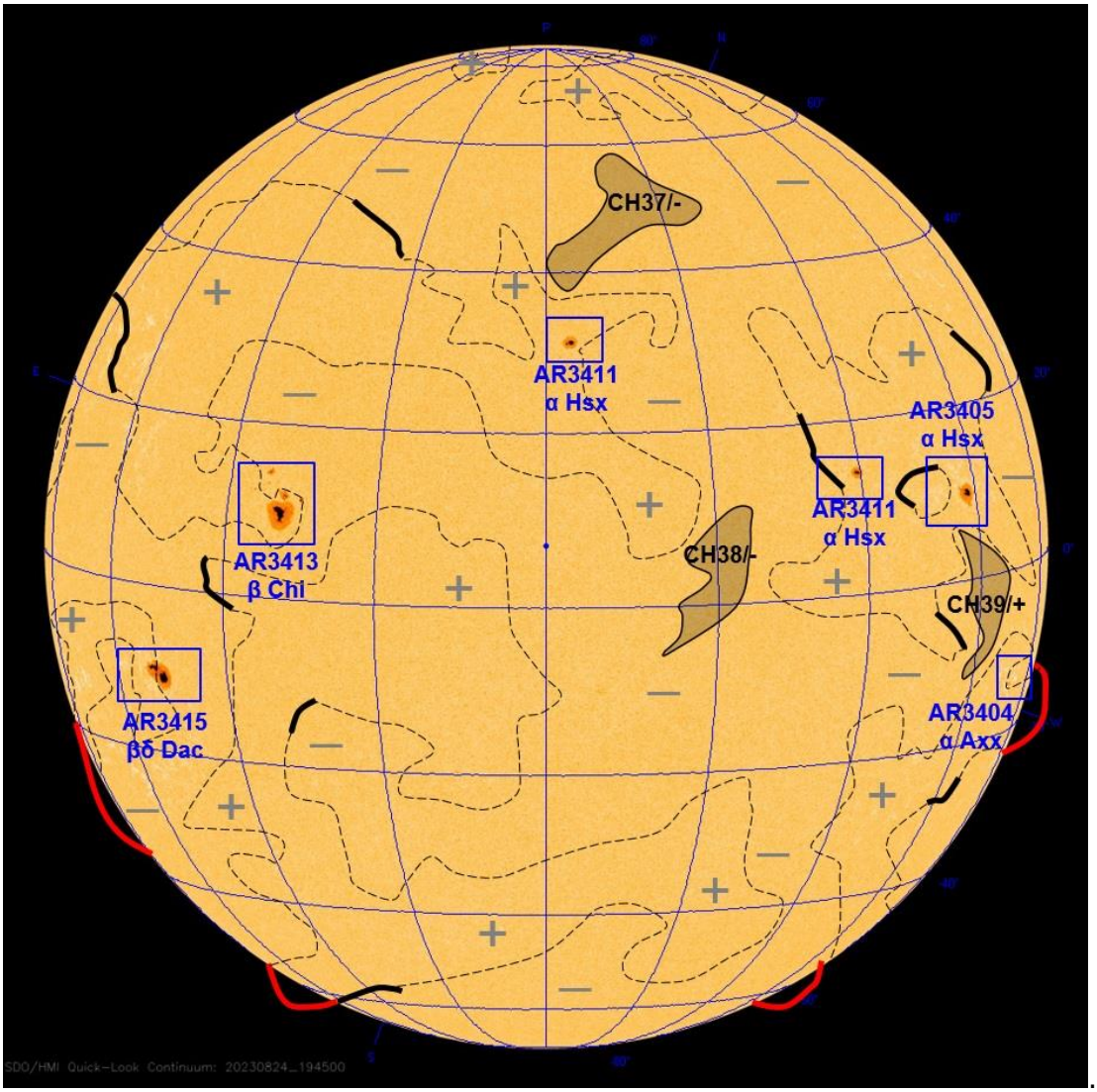
Unsettled with Active intervals.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background levels. High energy (greater than 2 MeV) electron flux is expected to rise in response to the current fast wind enhancement, to more persistently Moderate and perhaps peaking at High day 2 (26 Aug). Any further fast wind arrival either late day 2 or day 3 (26-27 Aug) will then likely drop out observed flux again. The associated 24 hour fluence is expected to remain below the Active level (1e8 integrated pfu).

Figure 1. Solar Analysis Valid 25/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-directed CMEs.

Earth recently transitioned into the late arriving, and slightly weaker than originally anticipated fast wind of CH39/-, with solar winds peaking around 500km/s. These winds are expected to continue early day 1 (25 Aug) before easing a little later in the day and much of day 2 (25-26 Aug). A further enhancement is then anticipated on either late day 2 or day 3 (26-27 Aug), due to the arrival of the next fast wind, most likely from CH38/- in the centre disc, but perhaps northern disc 37/-. Solar winds then easing again day 4 (28 Aug)

27-day persistence provides little guidance for expected arrival times, and Enlil has a poor representation of current conditions reducing confidence in the model forecast. However, this does suggest an enhancement around 26-27 Aug, with the later arrival currently preferred. Any connection to this hole is also likely to be limited due to its negative polarity and the Russel-Mcpherron effect.

Unsettled to Active geomagnetic activity is forecast at first, with a slight chance of G1 Minor Storm intervals. This easing early day 1 (25 Aug) to become mainly Quiet with isolated Unsettled intervals. The arrival of any CIR and associated fast wind of CH38/+ late day 2 or day 3 (26-27 Aug) is then forecast to increase activity to Unsettled with Active intervals. Given the low confidence and unfavoured coronal hole polarity, there is only a slight chance of G1 Minor Storms.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	5	10	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2a: SDO aia-193 (left) and SDO aia-211 (right)

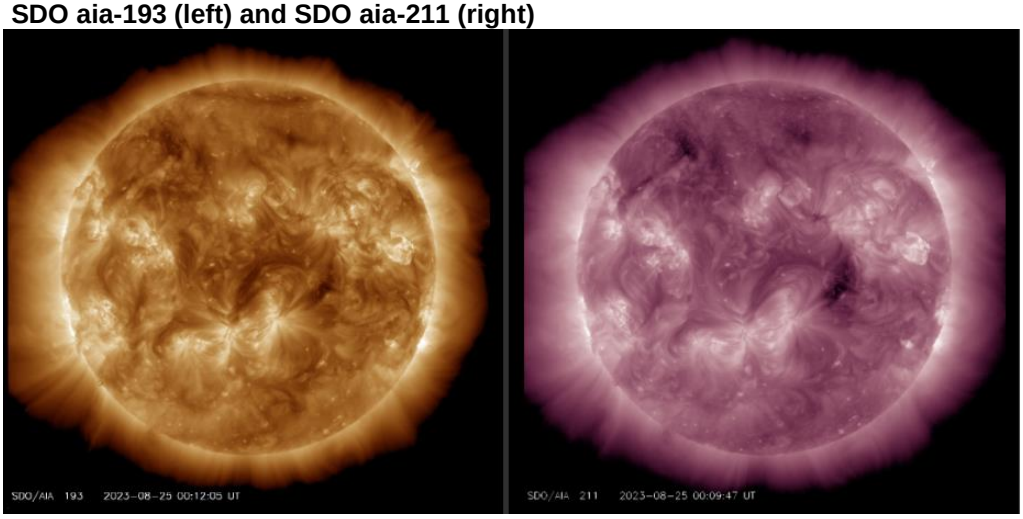

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Figure 2b: L1 observed solar winds

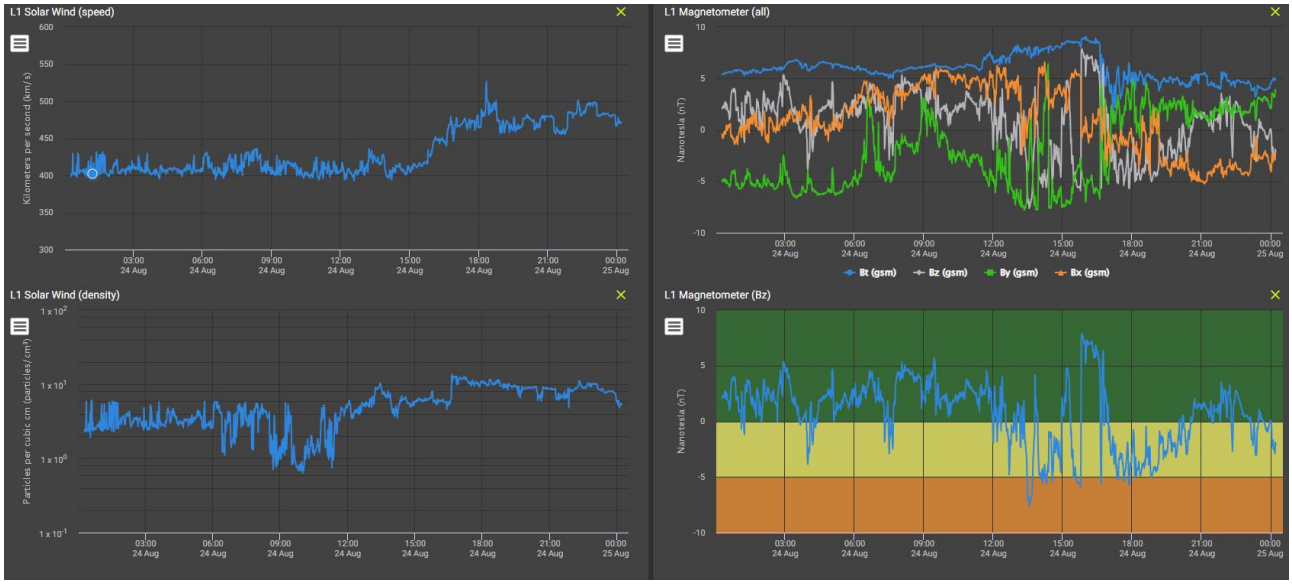
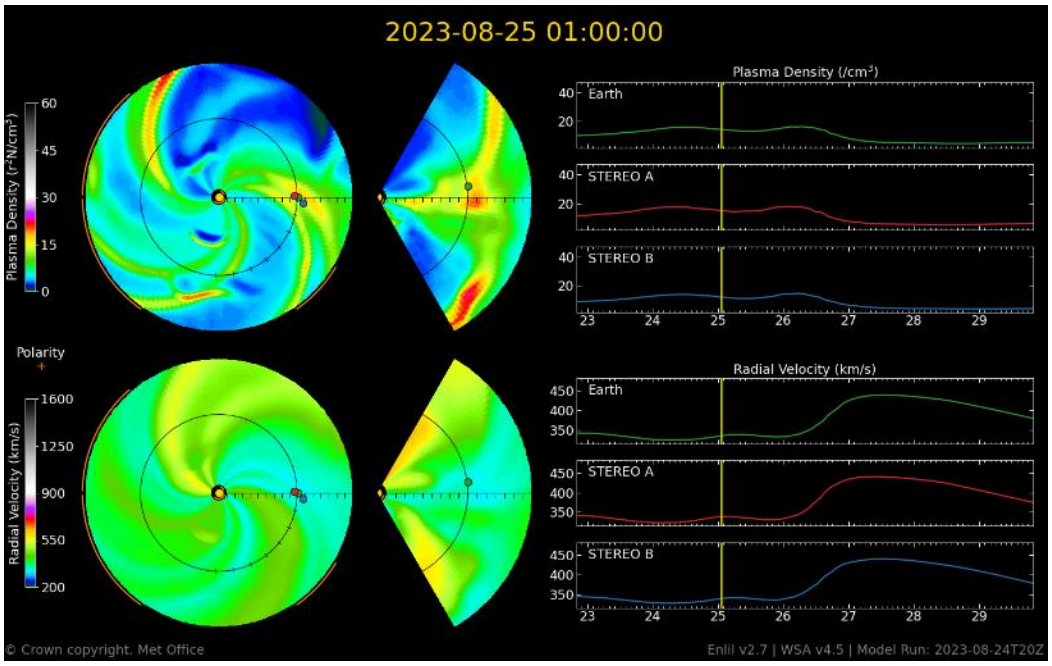


Figure 2c: Current Enlil expectations



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Radio Blackouts - X-Ray Flares:

Low activity is expected to continue, but with a chance of rising to Moderate due to a risk of isolated M-flares throughout. A very isolated X-flare cannot be completely ruled out.

There are currently five sunspot regions on the disc, with AR3405 in the northwest currently the most active. This appears to be a mature and simple spot, but does have a preceding plage area with a nearby filament and also SDO imagery perhaps suggesting some more complex magnetic looping that is potentially obscured due to it now approaching the northwest limb. Overall, this remains a small spot however and unlikely to produce significant flares.

The main flare risk remains AR3415 in the southeast. This has been a surprisingly inactive region, as despite its modest size, it is clearly comprised of two opposite polarity and moderately strong umbra sharing a single small penumbral area. Any development or destabilisation of this region has the potential to generate a reasonable M, or perhaps low X-flare. AR3413 is the largest spot on the disc, and with an east-west polarity separation line, also has the potential for notable flare activity. However this region has shown some signs of simplification in the last 24 hours, with decay of its trailer spots to its northeast.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3a: GOES-16/18 X-ray flux

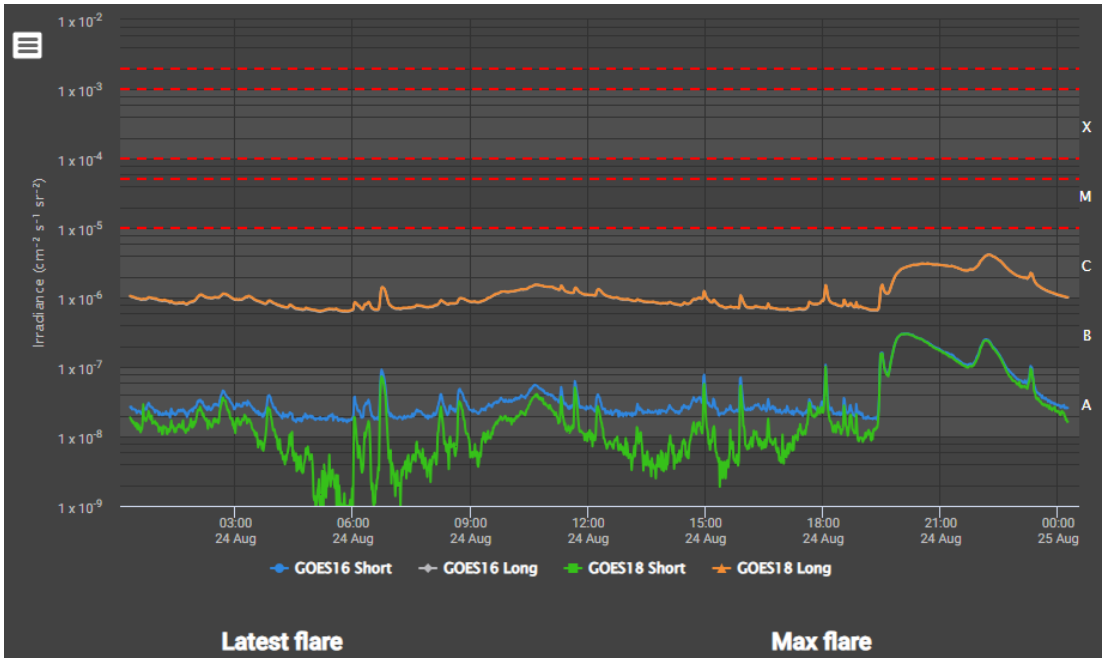

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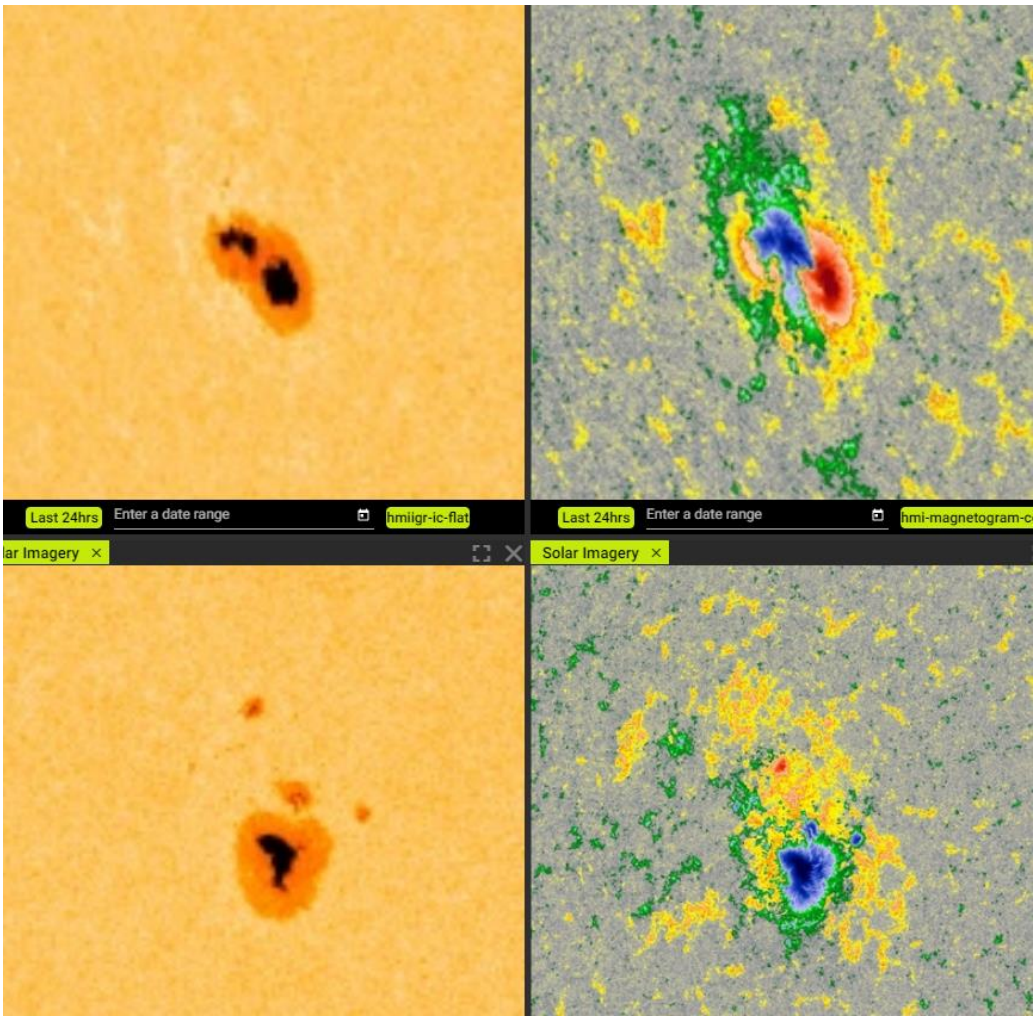
Figure 3b: SDO aia-intensitygram and magnetogram of AR3413 (top) and AR3415 (bottom)



Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux observed by GOES16 is expected to remain at Background. The main risk of any increased proton flux would be from the occurrence of any larger flares of AR3415 or AR3413, currently both in the eastern hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2 MeV) electron flux observed by GOES16 is currently Background to Moderate, but expected to rise in response to the current fast wind enhancement, perhaps more persistently Moderate later day 1 (25 Aug) and with a chance of peaking at High day 2 (26 Aug). A further fast wind enhancement either late day 2 or day 3 (27 Aug) from CH38/- will then likely lead to flux dropping out to background. The connection to this feature is expected to be more limited than the current fast wind, with flux potentially only recovering to Moderate later day 4 (28 Aug).

The associated 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) level, but rising in response to the recent solar wind enhancement, before declining again later day 3 (27 Aug) onward due to any further HSS enhancement. REFM is likely to be poor guidance currently, as it has yet to account for the recent solar wind increase.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	10	10	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: >2MeV Electron Flux and associated Fluence with REFM

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